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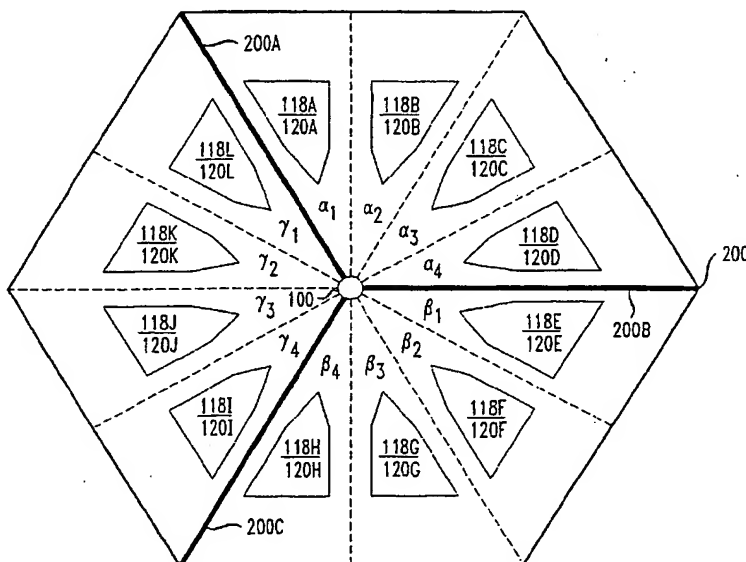
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### (54) System and method for beam on demand

(57) A beam on demand antenna system and method for automatically allocating amplifiers and antennas to various sectors of a wireless communication system to meet the capacity demands of the sectors. The transmission power levels of equipment assigned to the sec-

tors are monitored by a controller which switches equipment amongst the various sectors such that the sectors operate at or below a power threshold established by the system provider of the communication system or by the manufacturer of the antenna system.

FIG. 2



system. The capacity demands of various portions of the communication system are met by switching equipment serving one portion to another portion of the communication system. The switching is done such that the portion of the communication system from which the equipment are switched will still be adequately served by the remaining equipment; that is, the remaining equipment will operate at or below a power threshold (or any other type of capacity threshold) established for the affected portion. Also, the equipment to which the switched equipment is added will also operate at or below its threshold. In sum, various equipment can be switched among the various portions of the communication system to prevent any portion from operating beyond its established capacity. For ease of explanation and illustration only, the present invention is described in terms of a cellular wireless communication where the portions of the communication system are portions of a cell called sectors and the switched equipment are amplifiers and antenna elements. It will be readily obvious that the method and system of the present invention is applicable to other types of equipment and other defined portions of a communication system.

#### Brief Description of the Drawings

[0008]

FIG. 1 depicts the beam on demand system of the present invention.

FIG. 2 depicts the assignment of equipment from the system of FIG. 1 to sub-sectors of a cell of a wireless communication system.

#### Detailed Description

[0009] The present invention is a beam on demand system and method for automatically allocating equipment to various portions of a communication system based on the capacity demands of the system. In a preferred embodiment of the system and method of the present invention, the beam on demand system determines the capacity demands of one or more portions of a wireless communication system in terms of the transmission power level of equipment assigned to the portions (e.g., sectors of cells) of a wireless communication system. The capacity demands of various portions of the communication system are met by switching equipment serving one portion to another portion of the communication system. The switching is done such that the portion of the communication system from which the equipment are switched will still be adequately served by the remaining equipment; that is, the remaining equipment will operate at or below a power threshold (or any other type of capacity threshold) established for the affected portion. Also, the equipment to which the switched equipment is added will also operate at or below its threshold. In sum, various equipment can be switched

among the various portions of the communication system to prevent any portion from operating beyond its established capacity. For ease of explanation and illustration only, the present invention is described in terms of a cellular wireless communication where the portions of the communication system are portions of a cell called sectors and the switched equipment are amplifiers and antenna elements. It will be readily obvious that the method and system of the present invention is applicable to other types of equipment and other defined portions of a communication system. It will be further obvious that the capacity demands of the various portions of a communication system can be defined in a variety of forms such as the number of users being served by the various portions or the amount of information being conveyed in the various portions; that is, the representation of capacity demands is not limited to only transmission power levels. The term "couple" refers to a procedure that allows one equipment to transmit signals to another equipment that receives the signals. The term "uncouple" refers to a procedure that prevents equipment (previously coupled) from transmitting and/or receiving signals between each other. The term "switching" refers to a procedure that performs a coupling and an uncoupling operation.

[0010] Referring to FIG. 1, there is shown the beam on demand system of the present invention comprising a plurality of amplifiers 118 whose inputs are switchably coupled to radios 102, 104 and 106 via beam formers 112, 114 and 116 respectively and switch matrix 108. Each output of each of the amplifiers is coupled to an antenna element of antenna array 120. The antenna elements and the amplifiers are arranged into three distinct groups where each group has several members. The first group comprises antennas 120A-120D and amplifiers 118A-118D. The second group comprises antenna elements 120E-120H and amplifiers 118E-118H. The third group comprises antenna elements 120I-120L and amplifiers 118I-118L. Radio 102 is assigned to the first group; that is, a signal originating from radio 102 is routed to beam former 112 by switch matrix 108. Beam former 112 processes the signal and applies it to an input of one of the amplifiers belonging to the first group. Radio 104 is assigned to the second group and radio 106 is assigned to the third group. Signals from radios 104 and 106 are similarly routed to the second and third group respectively. It will be readily understood that the beam on demand system of the present invention comprises other type of equipment (e.g., microprocessors, filters, computer hardware) typically used by communication systems and is thus not limited to the equipment shown in FIG. 1. In essence, FIG. 1 depicts equipment provided by a service provider so as to serve various portions (e.g., sectors, sub-sectors of a cell) of a communication system.

[0011] Each of the amplifiers in all three groups generates a transmission power level signal received by controller 110 via path 122. Controller 110, which con-

tor  $\alpha$  is detected by controller 110 of antenna system 100 which compares it to the transmission power threshold set for the first group. The controller then decides, based on criteria set by the service provider or the manufacturer of the antenna system, whether the aggregate transmission power level warrants switching some of the equipment from sector  $\alpha$  to another sector in order to lessen the capacity demands on the equipment serving sector  $\alpha$ . Controller 110 will then determine the aggregate power of the other groups and further determine whether any of the other groups can still operate below their set power threshold even after some of the equipment (i.e., members) from the first group is switched to one or more of these other groups. Controller 110 makes these determinations by comparing the aggregate power of the groups with the power threshold established for the groups. Controller 110 will then select one of those groups which can still operate within its threshold even after having additional equipment is switched to it.

**[0017]** In sum, controller 110 generates the control signal causing equipment to be switched between portions of the communication system to meet the capacity demands of the various portions. For example, equipment is automatically transferred (or allocated) from one portion to another portion to meet the capacity demands of one or both portions. Controller 110 first determines the capacity demands of the portion of the communication system to which equipment is to be switched. Controller 110 causes the equipment to be switched when the capacity demand of the portion is calculated (or determined) to be below an established capacity threshold (e.g., power level, number of subscribers, amount of information) even after the equipment has been switched.

**[0018]** The equipment (from the first group) to be switched to the another group can be selected by controller 110 based on a variety of criteria. For example, controller 110 can select the equipment serving a sector that has the highest capacity demand in the first group and switch those equipment to another group. Controller 110 can also select several members of the first group and switch those equipment to another group. Regardless, of what criterion is used by controller 110, it switches certain equipment from the first group until the aggregate power transmitted by the remaining equipment of the first group operates below the set power threshold for the first group and the group to which the switched equipment is added also operates below its established power threshold.

**[0019]** Alternatively, a power threshold can be established for each member in a group of equipment instead of a threshold for the overall group of equipment. In such a case, controller 110 will compare the power transmitted by a member of the group to the power threshold established for that member. Controller 110 will switch equipment from the group to another group until each member of the remaining group operates at a power level below the threshold set for that member.

**[0020]** Continuing with our example, controller 110

has determined that the second group of equipment (serving sector  $\beta$ ) can still operate below its threshold even after amplifier 118D and antenna element 120D are switched to it. Controller 110 generates a control signal onto path 124 causing switch 108 to uncouple amplifier 118D and antenna element 120D from radio 102. Amplifier 118D and antenna element 120D are now coupled to radio 104 which is serving sector  $\beta$ . Thus, sector  $\beta$  has in effect been expanded to include a fifth sub-sector. The control signal on path 124 causes signals heretofore originating from radio 102 and transmitted through amplifier 118D and antenna element 120D to now originate from radio 104. Controller 110 can continue to switch equipment from one group to another group to allow each group to operate below its capacity threshold.

**[0021]** The system of the present invention is not limited to any particular implementation. Antenna array 120 can also be implemented as a group of antennas each of which is coupled to an output of an amplifier. Controller 110 can be implemented with a microprocessor and control circuitry or as a digital signal processor. Radios 102, 104 and 106 are implemented as analog/digital radio circuitry, or other well known radio circuitry typically used in wireless or wireline communication systems. Switch matrix 108 can be implemented as any well known digital and/or analog switch matrices for routing radio signals.

## Claims

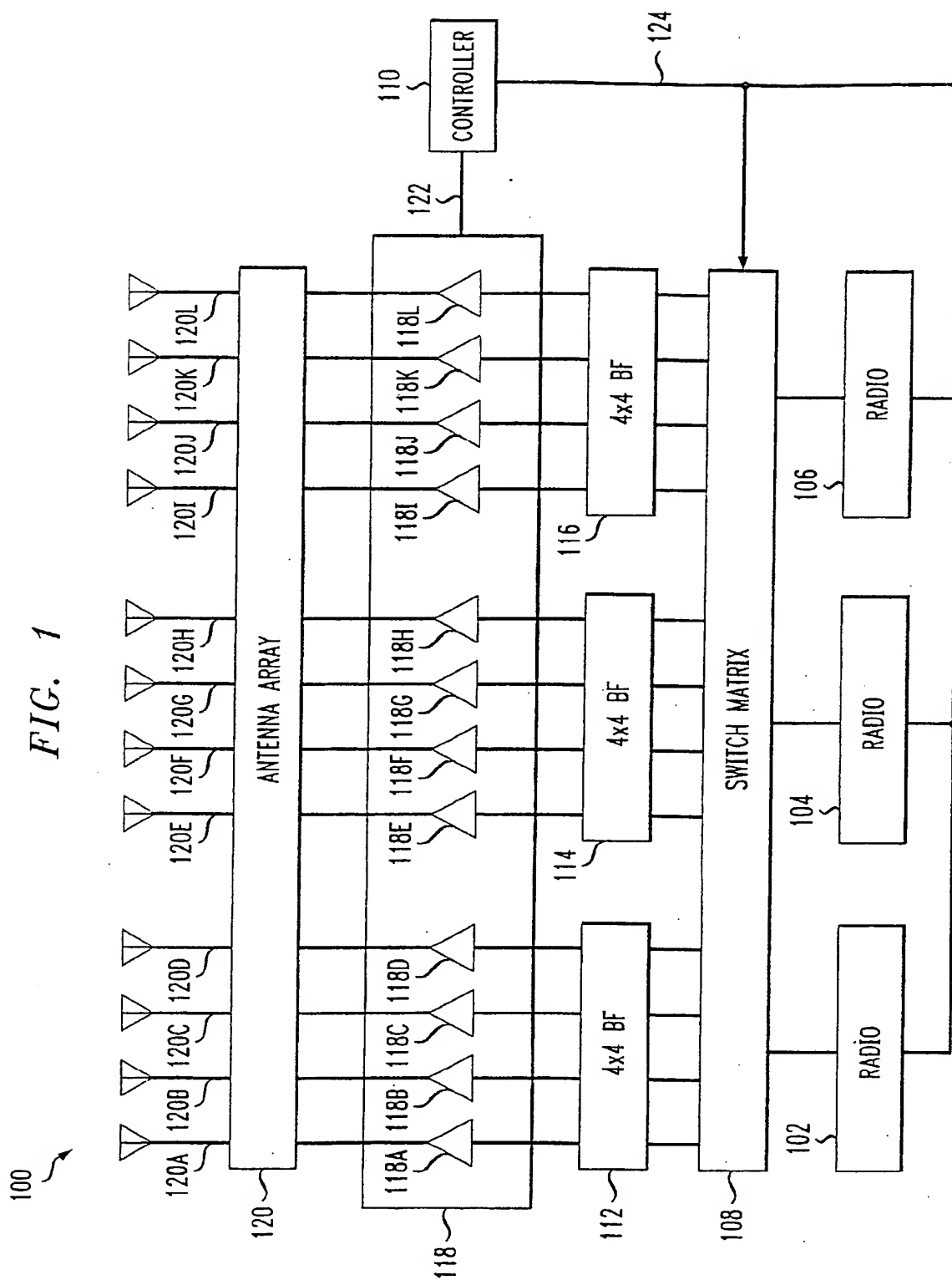
### 1. A beam on demand system comprising:

at least one radio;  
a plurality of amplifiers each having an input switchably coupled with the at least one radio by means a switch matrix and with at least one beam former, each amplifier having at least one output coupled to an antenna array; and  
a controller for receiving an output transmission power level signal from each of the plurality of amplifiers, wherein the controller generates a control signal to the switch matrix for causing the switch matrix to couple or uncouple an amplifier to the at least one radio, wherein the control signal is based on the received transmission power level of the amplifier and a threshold transmission power.

2. The beam on demand system of claim 1 wherein the controller couples or uncouples an amplifier from the at least one radio based on whether the received transmission power of the amplifier is above or below the threshold transmission power.

3. The beam on demand system of claim 1 wherein the amplifier and a corresponding antenna element

FIG. 1





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# EUROPEAN SEARCH REPORT

Application Number  
EP 02 25 0806

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 01 15477 A (METAWAVE COMM CORP) 1 March 2001 (2001-03-01) * abstract * * page 6, line 1 - last line * * page 8, line 3 - line 18 *	1-10	H04B7/04 H04Q7/36
A	US 5 771 017 A (DEAN STUART JAMES ET AL) 23 June 1998 (1998-06-23) * abstract * * column 3, line 25 - column 4, line 3 * * column 5, line 66 - column 6, line 45 * * column 11, line 58 - column 12, line 50 *	1-10	
A	WO 00 48272 A (MOTOROLA LTD) 17 August 2000 (2000-08-17) * abstract * * page 2, line 7 - page 3, line 7 * * page 8, line 4 - line 20 * * page 10, line 24 - page 11, line 8 *	1-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H04B H04Q
The present search report has been drawn up for all claims			
Place or search <b>THE HAGUE</b>		Date of completion of the search <b>23 May 2002</b>	Examiner <b>Lustrini, D</b>
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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